ENERGY SERVICES FOR THE RURAL POOR: A COMPARATIVE ANALYSIS OF SOLAR SERVICE CENTRES AND MULTIFUNCTIONAL PLATFORMS AND LESSONS FOR GHANA

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ABSTRACT
Solar service centres and multifunctional platforms are innovative concepts for providing energy services in poor rural communities. For some communities, because of the size and dispersion of their location, grid-electricity is non-existent and therefore a solar service centre or a multifunctional platform is the only viable option for lighting, refrigeration, water pumping, powering of equipment etc. Though they contribute to socio-economic development of rural communities, it is however argued that the two energy services provide different frontiers of contribution to energy security. This paper therefore compares these energy services and shows how they have contributed to reduce energy-poverty in rural Ghana and Burkina Faso. The scope of the analysis covers deep-seated empirical lessons on investment costs, benefits and welfare gains, and potential in direct productive and spin-off energy demand sectors. The purpose is to draw lessons to inform rural people, energy policy makers, and development experts on both good practices and failures of the two forms of energy services. Evidence from the surveys confirms that, solar service centres and multifunctional platforms are fundamentally suitable for use in poor rural communities. However, the concern is what to go in for when faced with the problem of choice, which is critical in meeting the needs of the rural poor.

Keywords: *Modern energy services, women, poor rural communities, Ghana, Burkina Faso.*

INTRODUCTION
In most rural communities of Sub-Saharan Africa majority of the adults are farmers who live in villages where poverty is noticeable as a result of low farming technologies, low economic activities, and poor access to modern energy services. In the West African sub-region, majority of food crop farmers are women, who contribute the most to rural poverty because of their low occupational opportunities and limited productivity due to lack of modern energy supplies (Anokye-Mensah, 2001). In the absence of modern energy services, the vast majority of the rural poor in the two neighbouring countries of Ghana and Burkina Faso depend on traditional fuels

such as wood, crop residue, dung and kerosene. These energy sources are primitive and inefficient (Rehling, 2004). For many years, the way in which traditional fuels are harnessed and used affects almost every sector of the economy. Fuel-wood, dung and crop residues are becoming scarce and labour intensive, while kerosene for lighting is becoming costly, environmentally inefficient and a health risk as a result of indoor air pollution.

According to the World Energy Council (1999), the combination of traditional fuels barely allows fulfilment of basic needs for nutrition, warmth and light, let alone the possibility of harnessing energy for productive uses that might permit the escape from the cycle of poverty. Because of the size and dispersion of location of some villages, grid electricity is non-existent and therefore a solar service centre (SSC) or a multifunctional platform (MFP) is the only viable option for lighting, refrigeration, water pumping, powering of equipment etc. The benefits of such energy services include: enhanced security of energy supply, reduced threat of climate change, improved social equity, stimulation of economic growth, protection of the environment and income generation (Renewables, 2004). Indications are that the availability of affordable energy services in rural communities is already transforming living conditions (Burn & Coche, 2001; UNDP, 2001).

Since 1995, solar service centres have been established in Ghana as an innovative initiative to support government's rural electrification programme. A solar service centre is a village shop where solar panels are installed to provide electricity services. Similarly, under a community based initiative for poverty reduction, multifunctional platforms have been established in Burkina Faso since 2000. A multifunctional platform comprises a village shed in which a centrally installed diesel engine powers a variety of equipment. Beneficiaries of both projects are poor villages where women in particular need reliable energy services to reduce drudgery and at the same time generate income.

This paper seeks to analyse the two forms of energy services by comparing their technological configuration, investment costs, benefits and welfare gains, and potential in productive energy demand sectors. Practical lessons learned from various case studies would help energy experts and practitioners to share more widely information on both good practices and failures of these energy services. The aim here is to have an optimum energy mix, which would meet the socio-economic needs of the rural poor.

DATA COLLECTION METHODS

Survey questionnaires, focus group discussion, semi-structured interviews, key informant interviews and recording of installed equipment were the major data collection methods used in the case studies. The survey of solar service centres was carried out within the framework of a CIDA funded University of Regina, Canada/ KNUST, Ghana renewables project in 1999, while that of multifunctional platforms was done in Burkina Faso in 2003.

In Ghana questionnaires, key informant discussions and recording of installed equipment were the main methods used. The survey covered a sample size of 60 respondents- 13 (22%) women and 47 (78%) men – out of which 54 were in seven rural communities of Ashanti, Brong-Ahafo, Eastern, Greater Accra and Upper-West regions and 6 were experts who work in Banks, Ministry of Energy and a solar company in Accra. In the seven rural communities respondents were randomly sampled from the members of the solar cooperatives formed in the villages, the technical operatives and the entire communities. Even though the questionnaires were prepared in English, local language - Twi was used to translate and communicate most of the content of the questionnaires to the respondents since majority of the respondents were very conversant with the local language. In some cases where translation of certain technical words was rather difficult English was used.

In Burkina Faso, focus group discussions, key informant interviews using semi-structured checklists, and recording of installed equipment were the major data collection method used in eliciting primary data from three villages, namely, Gomore (220 km from Ouagadougou), Nagbingou (225 km from Fada N'Gourma) and Soaligu (90 km from Nagbingou). The survey covered a sample size of 35 respondents – 20 (56%) women from three different women's groups and 15 (44%) men. The men comprised 2 (6%) multifunctional platform experts, 3 (9%) technical operatives, 2 (6%) village chiefs, 5 (14%) village artisans, and 3 (9%) policy experts from Ministry of Energy, UNDP-Ouagadougou, and Community-based Initiatives Support Programme for Poverty Reduction (PAICB). Questions were posed to the various women's groups in English and in few cases in French. Different local experts who joined the team from village to village translated the questions and responses in the local languages and vice versa. Communication was not a barrier to data collection in the study areas. Statistical processing of data was undertaken in the Kwame Nkrumah University of Science and Technology, Kumasi using MS Excel 2000. In all, data from 95 respondents were analysed for the discussion.

RESULTS AND DISCUSSION

The results showed that the multifunctional platforms surveyed had capacities equivalent to the electrical power units of 150-200 bulbs of 20 watts (W). In the case of the solar service centres, apart from Wechiau centre (Upper-west region), which had a capacity of about 2 kilowatts, the studied centres were equipped with 290-300 peak watt (Wp) capacity solar facilities equivalent to 14-15 bulbs of 20 watts.

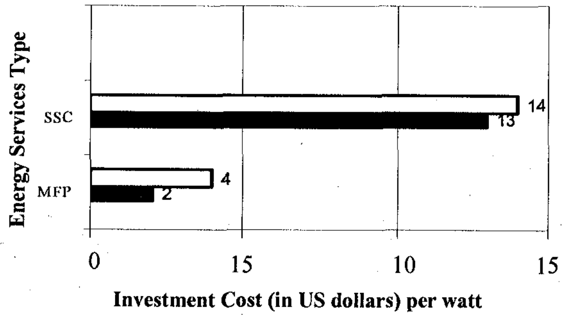
Technological Configuration

The configuration of equipment recorded in the solar service centres includes: solar modules, charge regulators, lead acid batteries, low voltage disconnect (cut out), radio, television etc. installed in a typical village store suitably located on the main road through a village centre. The purpose of a solar service centre is to provide renewable energy services that will enhance social and economic activities in the communities. Such services are generally provided for lighting of homes, with installed capacities of 40-80Wp; lighting of health centres and refrigeration, with installed capacities of 200-600Wp; water pumping with capacities of 500-1500Wp and charging of lead acid batteries (Biermann, 1989). Similarly, a multifunctional platform was found to be a village shed in which a configuration of a diesel engine and a variety of end-use equipment such as a flour mill, a battery charger, a vegetable oil mill, and a welding machine were mounted on a steel chassis. According to Burn & Coche (2001), a platform can support mini grid for lighting 150-200 bulbs of 20W and electric pumps for a small water distribution network or irrigation system.

Investment Costs

To establish a multifunctional platform of capacity equivalent to 150-200 bulbs of 20W, a capital investment (excluding cost of land) of about CFA 4.5 million (US$ 7000-8000) was required in Burkina Faso (Y. Lompo, unpublished) and about US$ 4,000 was required in Mali (UNDP, 2001). In situations where the supply of electricity and running water were requested, project contribution could increase up to US$10,000 (Sokona, 2002). A comparatively small unit of solar service centre of capacity equivalent to 14-15 of 20W bulbs (280-300W) required investment capital (including renovation of village store, cost of hand tools, voltmeter, hydrometer etc) of US$ 4,000-4500 in Ghana (Obeng & Quansah, unpublished).

All things being equal, if the cost of investing in each energy service is simplified for comparison, about US$13-14 per Watt (US$13,000-14,000 per kW) in year 2000 was required to invest in a typical community solar service centre, whereas about US$2-4 per Watt (US$2000-4000 per kW) in year 2003 was required for establishing a typical community multifunctional platform (Figure 1).



Source: Field data, 2000-2003

Figure 1: Investment costs (US dollars) per watt required for typical SSCs and MFPs

It is worth noting that in both situations the communities provided land and labour during construction. Again, the investment costs for the two energy forms vary according to geographic location and site, administrative issues, cost of local materials and labour, local technical capacity, and finance schemes. Comparing the above investment costs to that of other renewables such as small hydropower (US$ 1000-5000 per kW), geothermal power (US$1200-5000 per kW), wind power (US$850-1700) in 2002 (IEA, 2003), the investment in a multifunctional platform compares favourably, while that of solar service centre is high.

In reality, unavoidable imports of solar modules contribute to high initial cost as compared to their alternatives. However, for rural applications such as battery charging for television, radio and lighting, solar service centres are economic and self sustainable (Akuffo and Kybett, 1995). Indications are that the cost of photovoltaic modules are declining and that the costs of 1 kilowatt stand alone photovoltaic systems would become cheaper by 2010 (Maycock, 1993; IEA, 2003). Maycock (1993) forecasts that the price per kilowatt would decline from US$ 5060 in year 2000 to US$3850 by 2010. A similar forecast by IEA (2003) indicates a decline in investment cost of solar photovoltaic from US$ 4500-7000 per kilowatt in year 2002 to US$ 3000-4500 per kilowatt by year 2010.

Zeitinger (1989) argues that in the energy sector in general and for solar photovoltaic systems in particular, economic comparisons based solely on investment costs are not really very useful. What counts are the costs per unit of energy consumed. However, the counter argument from Weingart (2000) is that even in terms of costs per unit energy consumed solar electricity cost of US$ 1-3 per kilowatt-hour is high; and it is a limitation on the use of small photovoltaic units. Commenting on the costs of solar electricity, a WBGU (2004) policy paper reports that solar electricity or solar-generated hydrogen is still comparatively expensive today. Being optimistic, the WBGU (2004) policy paper is also hopeful that the costs of supply of solar electricity will decline continuously and considerably with growing market volume. Since solar technologies are in transition compared to multifunctional platforms, which are fundamentally centered on the aged diesel engine technology, multifunctional platforms tend to be cheaper because of many years of learning, technology advancements and economies of scale (Renewables, 2004).

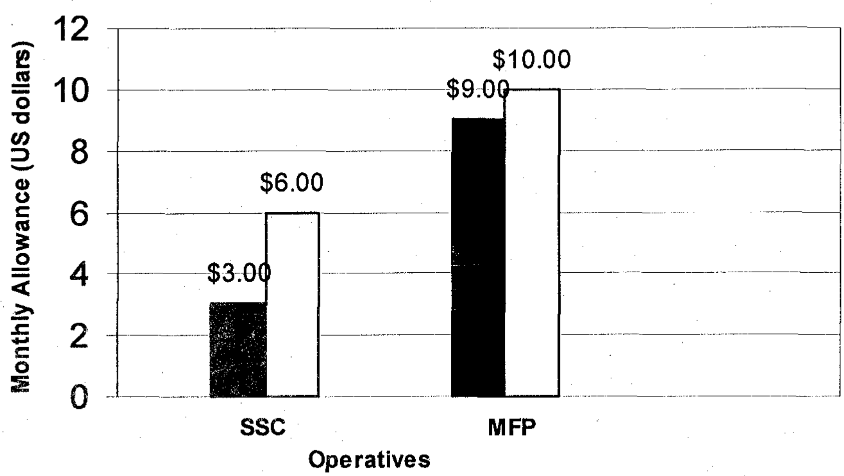
Drawing on the foregoing findings and public debates about possible introduction of subsidies to rural users of solar electricity, it is envisaged that the financial sector and private investment would provide the necessary finance to expand the market of solar photovoltaic systems. Government policies and funding are also required to ensure a level playing field for renewables in general, and solar electricity in particular, to be competitive with conventional grid electricity.

Benefits and Welfare Gains

Taking into consideration welfare gains such as increased employment and additional income generation, multifunctional platforms and solar service centres have some points of likeness. The survey results showed that the multifunctional platforms employed about 12 operatives in each village (over 80% being women) comprising operators, cashiers, controllers, treasurers and a president. While the solar service centres employed two operatives who were assisted by a 11-member solar cooperative. In two out of the three multi-functional platforms surveyed, the operatives were paid fixed salaries or 15-20% of daily proceeds. In Gomore village for example, the machine operator reported a net monthly allowance of CFA 5,350 (US$ 9-10) in 2003.

In the case of the solar service centres, depending on the number of charging lines (in most cases one to three lines), monthly allowance of operatives averaged 30,000-60,000 cedis (US$ 3-6) in 2003 (Figure 2). Such income levels reflect poverty, inasmuch as they fall below the US$1 per day poverty line. Although the socio-cultural and economic conditions of Ghana and Burkina Faso differ slightly, the scope of the discussion centers on poor rural communities, where income levels are generally below the international poverty line of US$1 per day (UNDP & UNICEF, 2002; UNDP, 2004).

Figure 2 depicts a significant difference in the incomes of the two operatives. What contributed to the difference was that while the core activity of the multifunctional platforms was food processing, which is a basic priority need of every community, that of the solar service centres was charging of batteries and installation of solar home systems. Lessons distilled from this finding is that to expand the revenue base of solar service centres in rural communities, other demand driven services such as solar crop drying, solar water pumping and solar communication centres should be integrated into the core business. Further results showed that because multifunctional platforms could mechanise the processing of local food crops, secondary industries, in local snacks and foods like *millet-porridge*, *kulikuli* and *moabu*, were created in the local economy of the platform communities.



Source: Field data, 2003

Figure 2: Monthly Allowance of Active Operatives of SSCs and MFPs

If the benefits of having a multifunctional platform or a solar service centre are defined to include non-marketed benefits such as virtually maintenance-free systems, zero fuel costs, low operational costs, no noise, and reduction in environmental pollution, then solar service centres have an edge over multifunctional platforms. On environmental issues, the survey found that the diesel engine of a multifunctional platform produces noise, thick black smoke and in some cases oil spills on the floor of the workplace. In addition, the configuration of milling, grinding or grating equipment produce in-house dusty conditions. Analysing the environmental effect an argument could be bolstered up that, if the combined volume of smoke and noise produced in a platform is compared to the individual volume of smoke and noise that would have been produced if every equipment was installed with a separate diesel engine, it could be claimed that a multifunctional platform produces relatively minimum volume of smoke and noise levels. On this count, although multifunctional platforms are fossil fuel dependent in meeting the needs of the rural poor, a variety of strategies and trade offs are very necessary.

In all the cases, the respondents reported of some social and economic benefits. In the multifunctional platform communities, the major benefit was on issues relating to the removal of much of the women's domestic drudgery associated with food processing. As a result of having the platforms all the women interviewed said they have time to rest and for other economic activities. The survey results revealed that before the multifunctional platforms were established some of the communities had no good sources of drinking water. Women could not have enough time to trade because they had to walk several distances carrying water on their heads. In addition, the women had to spend more time to grind or pound their food crops. The multifunctional platform projects, which brought along hand-dug wells enabled rural women and girls, who used to carry loads of water for the entire family to have some spare time to engage in income generating activities.

Fifteen (75%) out of the 20 women reported that they could buy new clothes for themselves and their families because the multifunctional platform had facilitated other secondary businesses in their communities. All the 20 (100%) women said they could spend more time on their farms during the rainy season and as a result had an increase in crop yield compared to their previous yields without the project. A significant impact of the concept of multifunctional platform was the education of the women who managed the platforms. In the villages the management team members were offered adult literacy training to enable them to keep financial records of their activities.

In the solar service centre communities the major benefit was centered on light and electricity supply. On a ranking of 1-5 (1 being no impact and 5 being most impacted) a ranking of 4.8 was obtained for the response - men and children spend more time at home as a result of availability of solar light and electrical power for television and radio. The differing behaviour of the men and children could be explained that, while they had more time to satisfy their personal desires for sports and entertainment, the women were rather engaged in activities that could meet the needs of the family (Schneider and Schneider, 1991). Another response - children use the availability of solar light to study in the night - received a ranking of 4.2 out of 5. This suggests that the project beneficiaries realised the effect of the project on education as a social service. However, there was no evidence to conclude that children who used the availability of solar light to study in the evenings performed better in their examinations. Since most respondents did not keep records of savings on candles and kerosene as a result of the availability of the solar service centres it was difficult to quantify the economic gains.

The availability of solar light enabled women to cook in the night attracted a lower ranking of 1.8. This response suggests that even though the rural women had better source of light to do their cooking, the drudgery associated with its preparation was not reduced. Although several factors could be adduced to support the fact that solar service centres were transforming conditions in the studied communities, there was little evidence to confirm its productive uses in the provision of motive power for small-scale industries in the rural communities.

Potential in Direct Productive and Spin-off Energy Demand Sectors

One out of the three operatives of multi-functional platforms said he had been welding broken hoes, donkey carts, donkey ploughs and bicycles at the platform. Depending on the costs of materials and other inputs he could generate CFA 500-1000 (US$1-2) per job in 2003. The inclusion of a welding plant in the variety of end-use equipment saved some of the rural people time and money needed to travel to nearby grid-electrified towns on roads that are difficult to use during rainy seasons. Whereas the communities having multifunctional plat-forms realised the direct productive uses through its contribution to food processing, increase in small business activities and generation of additional income from off-farm activities, those having solar service centres gave a lower ranking of 1.5 to the response on-enhancement of local economic activities. The lessons distilled from the broader data is that, for energy services to be affordable to poor people, it has to be for end-uses that are directly productive and income generating (UNDP, 2001). Burn and Coche (2001) also comments that, there is the urgent need for rural women in Mali and other sub-Saharan Africa countries to substitute their own energy for those that can provide income and benefits for themselves and others.

In the discourse on productive uses of electricity, many are those who are of the opinion that solar technologies barely meet the productive needs of the rural poor. Such arguments arise from the misunderstanding of the concept of production and productivity. Gillis et al (1992), Byrns and Stone (1981) explained that productivity is influenced by skills and the use of technology. Production occurs when we use knowledge or technology to apply energy to make materials more valuable. To reinforce their argument, Byrns and Stone (1981) illustrate that, "for example, pouring a cup of coffee is productive-the coffee is more valuable in the cup than it was in the coffee pot". Drawing on this illustration, it is argued that there is the need for the rural poor (in collaboration with experts) to identify productive activities apposite to their own social and economic development. It is argued that, if a rural woman uses the evening solar light to sew clothes, or a village drinking bar plays music to attract more customers, are these not productive activities? All of these are issues of concern, which people would like to deepen their understanding.

The survey found that in communities having solar service centres the availability of solar lights in the evenings contributed significantly to the extension of working hours of small businesses who took advantage of the light to trade in oranges, bread, snack foods and cooked foods. About 78% of the respondents in these communities said their working hours increased up to 2 hours, another 17% reported of an increase in working hours of 3-5 hours. In terms of revenue, those who directly used solar light for commercial purposes easily realised an increase in revenue. About 35% of the respondents said their revenue increased by 10-30%, another 28% of the respondents reported of revenue increase above 30%, while 37% did not respond. Further results from the survey of solar service centres revealed that the centres could open avenues for the sale of lead acid batteries, dc lamps and accessories, electronic repair shop among others. In the case of the multifunctional platform communities, it was found that the platform could generate small business for repair artisans, metal workers, and equipment spare parts suppliers. The survey results confirmed that, solar service centres and multifunctional platforms have the potential to create new markets in the local economies of poor rural communities.

LESSONS FOR GHANA

One of the major lessons learned was that, generally energy-poverty trap has been the common enemy whose effects solar service centres and multifunctional platforms sought to mitigate. The demand for either a solar service centre or a multifunctional platform has been driven by the need for modern energy services in poor rural communities, where grid-electricity is non-existent. In the multifunctional platform communities the driving force behind the project was the women's groups in the villages. They were formed primarily to serve their collective interests on issues vital to their livelihood. In the solar service centre communities men who needed electricity to light their homes and to power their appliances were at the forefront to acquire solar home systems. Although the men discussed the financing arrangements, it was the women who made the decisions on where to fix the solar lights. A key lesson for Ghanaian experts and policy makers is that reliable energy services that meet the priority needs of rural people, planned with them taking local conditions into account, have a better chance of success.

Worth mentioning is the issue of ownership at the community level when a project is initiated through government, NGOs or donor funding. In the solar service centre projects it was learned that privately-owned centres were better managed than the community-owned centres. The reason was that through the centres some people acquired solar home systems under a favourable hire-purchase scheme and therefore paid more attention to their own home systems than the community one. This phenomenon, however, did not occur in the multifunctional platform projects, because individual women could not afford the cost of the equipment. Again, the initial project response was to expand existing units of diesel engine-mill owned by the various women's groups in the communities. Because the women needed a sustainable intervention to reduce the drudgery of domestic and commercial food processing, they worked as a team to manage the platforms. The implication here is that any labour-intensive strategy of growth for poverty reduction that would require human-energy overload could be counter-productive and bound to fail (Burn & Coche, 2000). Such micro-level data are required for policy and planning of rural energy projects in Ghana and other African countries.

Lack of credit facilities in the form of soft loans for acquisition of tools was another challenging issue that confronted the women in the multi-functional platform communities. In some cases the women needed credit to purchase farm implements to extend their farms. The lesson to be distilled is that, macro-level policy and planning of rural energy services would require favorable terms micro-credit schemes to empower adults, especially women, to engage in income generating activities.

Other challenging issues faced by the communities included poor remuneration of operatives, unavailability of spare parts and increase in system downtime. In general, the repair and maintenance of the components built into energy systems require electrical/electronics or basic artisanal/mechanical skills. In the surveyed communities, whenever a fault occurred the operator(s) had to contact repairers outside their communities. It took several days before defective parts were either repaired or replaced. An implication for policy is that at the planning stage of rural energy projects effective methods of training village artisans and electricians should be well considered. Locally trained operatives should be well equipped with spare parts and tools to enable them to repair defective parts. This will strengthen the capacity of local resource persons at the community level.

CONCLUSION

Data from the studied projects have provided significant insights into the appropriate energy services needed to contribute to energy-poverty reduction in rural communities. The scope of the comparative analysis covered deep-seated empirical lessons, which sought to share more widely information on both good practices and failures of the two forms of energy services. The paper raised arguments that were situated within a larger literature on rural energy-poverty. Evidence from the surveys confirmed that solar service centres and multifunctional platforms are fundamentally suitable for poor rural communities. However, the high cost per unit of solar energy is a limitation. Whereas the investment in a multifunctional platform compared favourably with other renewables that of solar service centre was comparatively high. In practice, unavoidable imports of solar modules and other components have contributed to the high initial cost of solar photovoltaic systems.

On productive uses, it is figured out that large-scale capacities of solar service centres without complementary productive services such as solar drying of crops, water pumping etc, might be untenable for rural applications owing to its limitation in productive services. Appropriate option worth considering for policy and planning of future energy services is a mix or hybrid of solar photovoltaics and multifunctional platforms or an integration of one into the other. This would be suitable for productive loads that would contribute to growth and sustainable development of poor rural communities in Ghana and sub-Saharan Africa.

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